DOCUMENT RESUME

ED 260 803 PS 015 270

AUTHOR Donaldson, Morag L.
TITLE Young Children's Production of Causal Connectives.
PUB DATE [83]
NOTE 18p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Comprehension; Foreign Countries; *Language Acquisition; *Logic; *Physical Environment; *Preschool Children; Preschool Education; *Psychology
IDENTIFIERS *Causal Connectives; Cause Effect Relationship; *England; Explanations; Physical Properties

ABSTRACT

In a series of elicited production experiments, eight 3-year-olds and eight 4-year-olds were asked to explain three types of phenomenon: physical, psychological, and logical. Three main findings emerged from an analysis of the children's uses of the causal connectives, 'because' and 'so.' First, the children made very few errors in producing the causal connectives. Only 6 percent of the children's uses involved inversions of the cause-effect relationship. Second, the children's ability to use the causal connectives appropriately did not vary according to the type of phenomenon being explained. Third, the explanations were appropriate to the type of phenomenon being explained. For example, the children usually explained physical phenomena in terms of physical causality. Thus, contrary to Piaget's claims (1929), the children did not tend to psychologize. Results are contrary to those of Piaget (1926, 1928, 1929, 1930) and also to those of several comprehension experiments (e.g., Corrigan, 1975; Kuhn and Phelps, 1976; Emerson, 1979). On the other hand, the present results are consistent with the results of Hood's (1977) production study. Possible reasons for the discrepancy in results are discussed with particular reference to the relationship between comprehension and production of language. (Author/RH)

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Young children's production of causal connectives.*

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MORAG L. DONALDSON

Plymouth Polytechnic

ABSTRACT

In a series of elicited production experiments, eight 3-year olds and eight 4-year olds were asked to explain three types of phenomenon: physical, psychological and logical. Three main findings emerged from an analysis of the children's uses of the causal connectives, because and so. First, the children made very few errors in producing the causal connectives. Only 6% of the children's uses involved inversions of the cause-effect relation. Second, the children's ability to use the causal connectives appropriately did not vary according to the type of phenomenon being explained. Third, the explanations were appropriate to the type of phenomenon being explained. For example, the children usually explained physical phenomena in terms of physical causality. Thus, contrary to Piaget's claims (1929), the children did not tend to psychologize.

The results of this study are contrary to those of Piaget (1926, 1928, 1929, 1930) and also to those of several comprehension experiments (e.g. Corrigan, 1975; Kuhn and Phelps, 1976; Emerson, 1979). On the other hand, the present results are consistent with the results of Hood's (1977) production study. Possible reasons for the discrepancy in results are discussed with particular reference to the relationship between comprehension and production of language.

* Address for correspondence: Department of Psychology, Plymouth Polytechnic, Drake Circus, Plymouth, England, PL4 8AA.

PS 015270

INTRODUCTION

In order to use the causal connectives, because and so, appropriately, children require both cognitive and linguistic abilities. They must have the cognitive ability to distinguish between causes and effects. In other words, they must realise that causal relations are unidirectional - that a cause brings about its effect rather than vice versa. Also, they have to be able to distinguish between different types of phenomenon and to give explanations which are appropriate (in terms of content) to the type of phenomenon being explained. Piaget (1926) distinguishes three types of content which can occur in explanations: physical, psychological, and logical. The following three sentences illustrate these three types of content:

(1) The window broke because a ball hit it. (Physical)

(2) Mary hit John because he pulled her hair. (Psychological)

(3) Half nine is not four because four and four make eight. (Logical)

Physical explanations invoke the laws of physics; while psychological explanations draw on psychological concepts such as motives, emotions and intentions; and logical explanations are based on the rules of logic or of other symbolic systems.

In addition to these cognitive abilities, children also require some specifically linguistic knowledge about how causal relations are encoded in language. In particular, they require knowledge about the meaning of the causal connectives, because and so. These words make the causal links in an explanation explicit, and they also indicate the direction of the causal relation since they signal which clause describes the cause and which clause describes the effect. The clause which immediately follows because describes the cause, whereas the clause which immediately follows so describes the effect.

Thus, the distinction between because and so can be summarised by saying that because is used to introduce the cause whereas so is used to introduce the effect. This distinction is illustrated by the following sentences:

(4) The cup broke because it fell. (EFFECT because CAUSE)

(5) Because the cup fell, it broke. (Because CAUSE, EFFECT)

(6) The cup fell so it broke. (CAUSE so EFFECT)

If children do not understand the meaning of because and so, then approximately 50% of their uses of these causal connectives are likely to involve cause-effect inversions, such as:

(7) *The cup fell because it broke. (CAUSE because EFFECT)

(8) *The cup broke so it fell. (Because EFFECT, CAUSE)

(9) *Because the cup broke, it fell. (EFFECT so CAUSE)

Piaget (1926, 1928, 1929, 1930) presents a rather negative picture of the development of both the cognitive and the linguistic abilities outlined above. He claims that until children are about 7 years old they are confused about the distinction between causes and effects, about the physical/psychological/logical distinction, and about the meaning of the causal connectives. Piaget predicts that children will understand psychological relations first, then physical relations, and finally logical relations. A related prediction is that children will tend to psychologize - that is, they will over-extend the psychological type of explanation and will give psychological explanations for physical and logical phenomena. Piaget further predicts that children below the age of seven will tend to produce cause-effect inversions when they attempt to use and understand the causal connectives. Piaget's own research provides support for all his predictions.

However, other researchers have reported evidence which conflicts with Piaget's claims about young children's understanding of causality. For example, studies by Bullock and Gelman (1979) and by Kun (1978) indicate that children as young as 3 years can distinguish appropriately between causes and effects. Also, the work of Huang (1943) suggests that children only psychologize as a last resort when they are asked to explain a phenomenon for which the causal mechanism is unfamiliar or opaque.

Piaget's claim that children do not understand the meaning of the causal connectives until the age of 7 years has received support from several comprehension experiments (e.g. Kuhn and Phelps, 1976; Emerson, 1979). On the other hand, studies of children's production have yielded findings which conflict with Piaget's claim. Hood (1977) observed 2 to 3 year olds' spontaneous production and found that only 7% of the children's uses of the causal connectives involved cause-effect inversions. Similar findings were obtained in a study by McCabe and Peterson (1985) in which 3 to 9 year olds were asked to talk to the researcher about various personal experiences. Again, cause-effect inversions were found to be very rare and no age trend was obtained - even the 3 year olds were using the causal connectives appropriately. Thus, there is a discrepancy between the results of the comprehension studies and the results of the production studies. It seems as if the ability to produce the causal connectives develops in advance of the ability to comprehend the causal connectives. This is a rather paradoxical situation - although not without precedent in the child language literature.

Hood (1977) and McCabe and Peterson (1985) note that, in their studies, children's uses of causal connectives usually expressed

psychological relations. Therefore, it may be that children's knowledge of the causal connectives' meaning is initially restricted to cases in which psychological content is being expressed. This would provide a possible explanation of the discrepancy in results between the comprehension and production studies. In a production study, children can choose to talk about psychological content and so will appear competent in their use of the causal connectives. Comprehension studies, on the other hand, typically include physical and/or logical content in addition to psychological content, and so they will tend to reveal any limitations in children's knowledge of the causal connectives' meaning. Thus the work of Hood and of McCabe and Peterson suggests an interesting hypothesis as to how the discrepant results might be explained. However, this hypothesis (that knowledge of the causal connectives' meaning is initially restricted to psychological content) cannot be tested on the basis of data from spontaneous production studies. The fact that young children preferred to talk about psychological content does not necessarily mean that they were incapable of talking about physi al or logical content in an appropriate way. The present study aims to overcome this problem by studying production in more constrained contexts which are designed to encourage the children to express physical, psychological and logical content.

METHOD

The subjects were eight 3 to 4 year olds and eight 4 to 5 year olds. All the subjects were attending the Psychology Department Nursery, University of Edinburgh.

Each subject was tested individually. The sessions were videotaped and then transcribed. All the subjects received three tasks. One task involved explaining a physical phenomenon, one a psychological phenomenon, and one a logical phenomenon. There was always an interval of several weeks between tasks, and the tasks were presented in the order: physical, psychological, logical.

The "physical" task made use of the materials from a commercially-produced game, Ker-Plunk. These consist of a vertical plastic tube down which marbles can be dropped, and a set of plastic sticks which can be inserted horizontally to prevent the marbles from falling. In the first phase of the experiment, the experimenter demonstrated the relations of physical causality associated with the apparatus. Throughout the demonstration, the child was encouraged to offer suggestions, predictions, descriptions and explanations. At certain points, the child was also encouraged to take part in inserting the marbles and in inserting or removing the sticks. In the second phase of the experiment, a large toy panda called Choo-Choo was introduced, and the child was asked to tell him how to play with the toy.

In the "psychological" task, the child was asked to explain why a character was experiencing a particular emotion. The materials consisted of two cardboard cut-out dolls (a boy for the boy subjects and a girl for the girl subjects), and two sets of four schematic faces showing different facial expressions: happy, sad, cross and scared. After introducing the child to the materials, the experimenter put one of the faces on the doll, named the facial expression, and asked the child to tell a little story about the doll. If necessary, the experimenter asked more directive questions, such as "Why is Jack sad?". The procedure was repeated until all four facial expressions had been presented (in random order).

The "logical" task involved a board game with arbitrary rules, in which two players threw a coloured die and raced toy mice over coloured stepping-stones to a piece of cheese. The colours on the die corresponded to the colours of the stepping-stones. The experimenter began by introducing the child to the materials and stating the rules of the game:

(i) The colour on the die has to be the same as the colour of the stepping-stone for you to put your mouse on the stepping-stone.

(ii) The mice must stay on the stepping-stones. They must not go into the water.

(iii) The mice must jump onto all the stepping-stones. They must not miss out any stepping-stones.

Then, the experimenter played the game twice with the subject, correcting any mistakes and re-stating the relevant rules. After this training phase, the toy panda was produced again, and the child was asked to tell Choo-Choo how to play the game. Finally, the child was asked to play the game with Choo-Choo and to tell him if he made a mistake. The experimenter made the moves for Choo-Choo and ensured that he made several mistakes in each game. If the child detected a mistake, the experimenter asked her to tell Choo-Choo why he was wrong and to correct him.

The first stage in analyzing the results involved dividing the transcripts into propositions, and making lists of the pairs of adjacent propositions between which a relation could potentially hold. Propositions were included in the list irrespective of whether the potential relation was causal or not, and irrespective of whether the clauses were linked by a connective or juxtaposed. The connectives which did occur in the original transcripts were omitted when the

lists were constructed. The lists of propositions and the original transcripts were laid aside for a week in an attempt to eliminate the effect of the connectives on the subsequent coding. Then each pair of propositions was coded according to the type of relation (e.g. conjunctive, temporal, causal) which seemed to hold between the two propositions. The relations which had been assigned to the causal category were coded for directionality. If the first proposition to be expressed referred to the cause, the relation was coded as "C->E". If the first proposition referred to the effect, the relation was coded as "E->C". If both directions seemed equally possible, the relation was coded as "ambiguous". Also, the causal relations were coded as physical, psychological or logical. Once all the codings had been made, the original transcripts were examined in conjunction with the coded list of propositions. An inversion was said to occur if there was a clash between the causal direction coding and the causal direction specified by the connective. The connectives included in this analysis were: because, so, that's why, if, and when. Any of the following pairings would be counted as an inversion: C->E + because (sentence-medial); C->E + if (sentence-medial); C->E + when (sentence-medial); E->C + so (sentence-medial); E->C + that's why (sentence-medial); E->C + because (sentence-initial); E->C + if (sentence-initial); E->C + when (sentence-initial). Those relations which had been coded as ambiguous in directionality were assumed to be inversions. Therefore, if anything, this method of analysis will tend to over-estimate the frequency of inversions. (Further details of the method of analysis are given in Donaldson, 1983.)

RESULTS

As Table 1 shows, the children produced very few cause-effect inversions in their uses of the causal connectives - the inversion rates are all considerably lower than 50%. (The 30% inversion rate for the 3 to 4 year olds in the Facial Expressions task should be interpreted with caution, since the corpus was so small). Like the findings of Hood (1977) and McCabe and Peterson (1985), these results indicate that young children understand the directional component of the causal connectives' meaning.

TABLE 1. Occurrence of inversions: expressed as proportions and as percentages of total number of uses of the causal connectives

	3 to 4 years		4 to 5 years		Total	
Ker Plunk	7/63	11%	9/137	6%	16/200	8%
Facial Expressions	6/20	30%	1/59	2%	7/79	9%
Game with Rules	1/49	2%	2/121	2%	3/170	2%
Total	14/132	11%	12/317	4%	26/449	6%

The results in Table 1 also indicate that the inversion rate does not vary according to the type of phenomenon which is being explained. Thus, the children's ability to use the causal connectives appropriately is not restricted to psychological content but extends to physical and logical content.

TABLE 2. Types of causal relation expressed as percentages of total number of uses of causal connectives for each age group and each task

	Physical	Psychological	Logical
3 to 4 years			
Ker Plunk	75%	21%	5%
Facial Expressions	0%	95%	5%
Game with Rules	0%	6%	94%
4 to 5 years			
Ker Plunk	67%	21%	12%
Facial Expressions	3%	93%	3%
Game with Rules	2%	20%	78%

If the children's explanations are appropriate, then there should be a close match between the nature of the phenomenon being explained and the type of relation expressed. More specifically, in the Ker Plunk task most of the utterances should express relations of physical causality, in the Facial Expressions task they should express relations of psychological causality, and in the Game with Rules task they should express logical relations. If, on the other hand, young children have a strong tendency to psychologize, expressions of psychological relations should predominate for all three types of phenomenon. The results presented in Table 2 provide evidence that, on the whole, the children's explanations were appropriate to the type of phenomenon. The largest percentage for each row and for each column has been underlined. In every case, the underlined percentage occurs in the cell where the type of phenomenon matches the type of relation.

DISCUSSION

The results of these elicited production studies give a promising picture of young children's cognitive and linguistic abilities. In terms of cognitive ability, the results indicate that young children are able to distinguish appropriately between causes and effects. This supports the findings of Bullock and Gelman (1979) and Kun (1978), but is contrary to Piaget's findings. The children in the present study also showed the ability to distinguish among physical, psychological and logical phenomena and to vary the type of relation which they expressed to take account of the type of phenomenon. Thus, the children did not show a strong tendency to psychologize. Again, this finding is contrary to Piaget's work. However, the lack of psychologizing is consistent with Huang's (1943) findings and with his hypothesis that psychologizing is a "last resort" strategy which children adopt only when faced with unfamiliar or opaque causal mechanisms. In the present study, the children were presented with familiar types of phenomena and the mechanisms of physical causality were demonstrated to the children. Therefore, according to Huang's hypothesis, psychologizing would be unlikely to occur.

In terms of linguistic ability, the results support Hood's (1977) and McCabe and Peterson's (1985) findings that young children are able to use the causal connectives in a systematically correct way (that is, without producing cause-effect inversions). Thus, it is clear that young children have some knowledge of the directional component of the causal connectives' meaning. The present findings extend Hood's and McCabe and Peterson's findings by showing that the low inversion rate occurs not only when children are explaining psychological phenomena, but also when they are explaining physical or

logical phenomena. This demonstrates the importance of drawing a distinction between what children CAN talk about and what they usually DO talk about. Although young children may tend to talk mostly about psychological relations, they can be encouraged to talk about physical and logical relations.

This study investigated one possible explanation of the discrepancy in results between comprehension and production studies of the causal connectives. It was suggested that young children's knowledge of the causal connectives' meaning might be restricted to expressions of psychological content. However, the results argue against this explanation. At the same time, the present findings are consistent with (and reinforce) the previously noted discrepancy between comprehension data and production data. Thus, we are still faced with the question: How might this discrepancy be explained?

There are two main types of possible explanation. It might be argued that the discrepancy in results between comprehension and production studies reflects a genuine difference between comprehension ability and production ability. In other words, comprehension ability and production ability may develop independently and so may sometimes be "out of phase". Alternatively, it might be argued that the discrepancy in results is attributable to methodological factors since different types of method are typically used to assess comprehension as opposed to production. We shall now consider each of these explanations in more detail.

The proposal that there may be a genuine discrepancy between comprehension and production raises the issue of the relationship

between these two processes. There are at least three possible views of the comprehension/production relationship. The first would involve adopting the Chomskean approach and arguing that both processes are guided by a single store of linguistic knowledge which is neutral with respect to the comprehension/production distinction. However, such an approach could not readily account for discrepancies between comprehension and production (without invoking a much more detailed analysis of the processes than is usually offered in this approach). A second possibility would be that there are two separate stores of linguistic knowledge: one guiding comprehension and one guiding production. These stores would be separate in the sense that information could not readily be exchanged between them. Therefore, at a given point in development, the two stores might be out of phase. If the production store contained some linguistic knowledge which the comprehension store lacked, then production would be in advance of comprehension in that particular area. This model does face a problem (although probably not an insurmountable one) in accounting for how information in the production store could be acquired other than through comprehension. A third possible approach would be to argue that the comprehension and production processes both have access to the same store of linguistic knowledge, but that the two processes differ with respect to the type of knowledge which they require. Thus, discrepancies in performance between comprehension and production would be attributed to the differential demands of the two processes rather than to the differential accessibility of a particular item of linguistic knowledge. These differential demands are related to differences between the task of being a speaker and the task of being a listener (in a natural communication situation).

Some of these differences work in favour of comprehension while others work in favour of production. Comprehension is usually supported by cues from the linguistic and non-linguistic context. Therefore, a listener can use various strategies which allow the message to be understood without complete comprehension of every word and of every aspect of the syntactic construction. On the other hand, one major advantage of being a speaker rather than a listener is that you usually have more choice or control over the content and form of the message. You can choose what to talk about, and you can choose how to express the message. Consequently, you can select or avoid particular words and syntactic constructions and so keep within the bounds of your own competence.

Let us now turn to the second type of explanation of the comprehension/production discrepancy: that the discrepancy is attributable to methodological differences between comprehension and production studies. There is a certain amount of overlap between this position and the third view of the relationship between comprehension and production. Both are concerned with differential demands. However, the "methodological" explanation deals with the differential demands imposed by comprehension and production studies, rather than with the differences between being a speaker and being a listener in a natural communication situation. The two types of differential demands coincide in some but not all cases.

Children's comprehension of linguistic forms is usually assessed by means of experimental rather than observational studies, because of the difficulty of controlling for contextual cues when dealing with comprehension in a natural setting. Thus, while comprehension of normal discourse may be assisted by contextual cues, this advantage

does not usually carry over to comprehension studies. In contrast, children's production of linguistic forms is usually assessed by means of observational methods or experiments which are less constrained than those typically used to assess comprehension. Thus, the advantages of being a speaker, as outlined above, usually do carry over to production studies. In a production study, children normally have a considerable degree of choice about the content and form of their utterances. Indeed, one of the major differences between comprehension and production studies concerns the balance of choice or control between the child and the investigator. In comprehension studies, most of the control typically rests with the investigator, whereas in production studies the balance of control tends to be with the child. As for the speaker/listener comparison, this difference in control applies to the content and the form of utterances, but there is also a third respect in which it is relevant to a comparison between comprehension and production studies. The design of a comprehension experiment usually reflects the investigator's assumptions about the nature of the knowledge which underlies linguistic comprehension. Very often, the comprehension experiment is designed to test for comprehension of one particular aspect of the meaning of a word and "irrelevant" cues are deliberately excluded to aid interpretation of the children's performance. Consequently, if the investigator's assumptions are not consistent with the type of knowledge which guides children's comprehension and production of the word in normal discourse, then children may fail in the comprehension experiment even though they have some knowledge of the word's meaning. In production studies, children typically have much more control over

the type of knowledge they use to achieve success. They do not necessarily have to use the particular type of knowledge which the investigator believes is relevant. This difference between comprehension and production studies could perhaps account for why children's production sometimes appears to be in advance of their comprehension.

The present study investigated the hypothesis that the comprehension/production discrepancy which occurs in causal connective studies may be attributable to the greater degree of control which production studies allow children with respect to the content of their utterances. Specifically, it was proposed that young children may only be able to use the causal connectives to express psychological relations. This hypothesis was not supported: The children also used the causal connectives correctly when talking about physical and logical content.

Elsewhere (Donaldson, 1983), I have presented evidence which suggests that the discrepancy may be related to a difference in the degree of choice which the children have regarding the type of knowledge they use to guide their performance. Many comprehension experiments appear to be testing for knowledge of the causal connectives' role as indicators of temporal order (e.g. because introduces the event which happened first) rather than of their role as indicators of causal direction (e.g. because introduces the cause). On the other hand, children's comprehension and production of the causal connectives in normal discourse is probably guided by a rule based on causal direction rather than temporal order, since the primary function of the causal connectives is to convey information about causality.

It is now generally accepted that different types of study will yield different pictures of children's linguistic abilities. However, there has been rather less discussion of the reasons for and implications of these discrepancies. It may well be that different comprehension/production discrepancies will require different explanations, so it is important to formulate and test specific hypotheses with respect to specific areas of language development. This paper illustrates the use of such an approach. It also highlights the importance of studying children's production of language in order to reduce the risk of under-estimating their linguistic abilities.

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